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The organization of the nature of science is emphasized through a focus on chemical reactions. Similarities of the reactions of the halogens with the alkali metals of lithium, sodium, potassium, and hydrogen are introduced to the student. Students are introduced to the periodic table of elements which emphasizes the organization of chemical elements into groups sharing like properties. Concepts of the atomic theory are discussed in relation to the periodic table of elements. The concepts include the structure of an atom, positive negative charges, electrons, protons, neutrons, mass, nucleus, atom particles, size, atomic number, and mass number.

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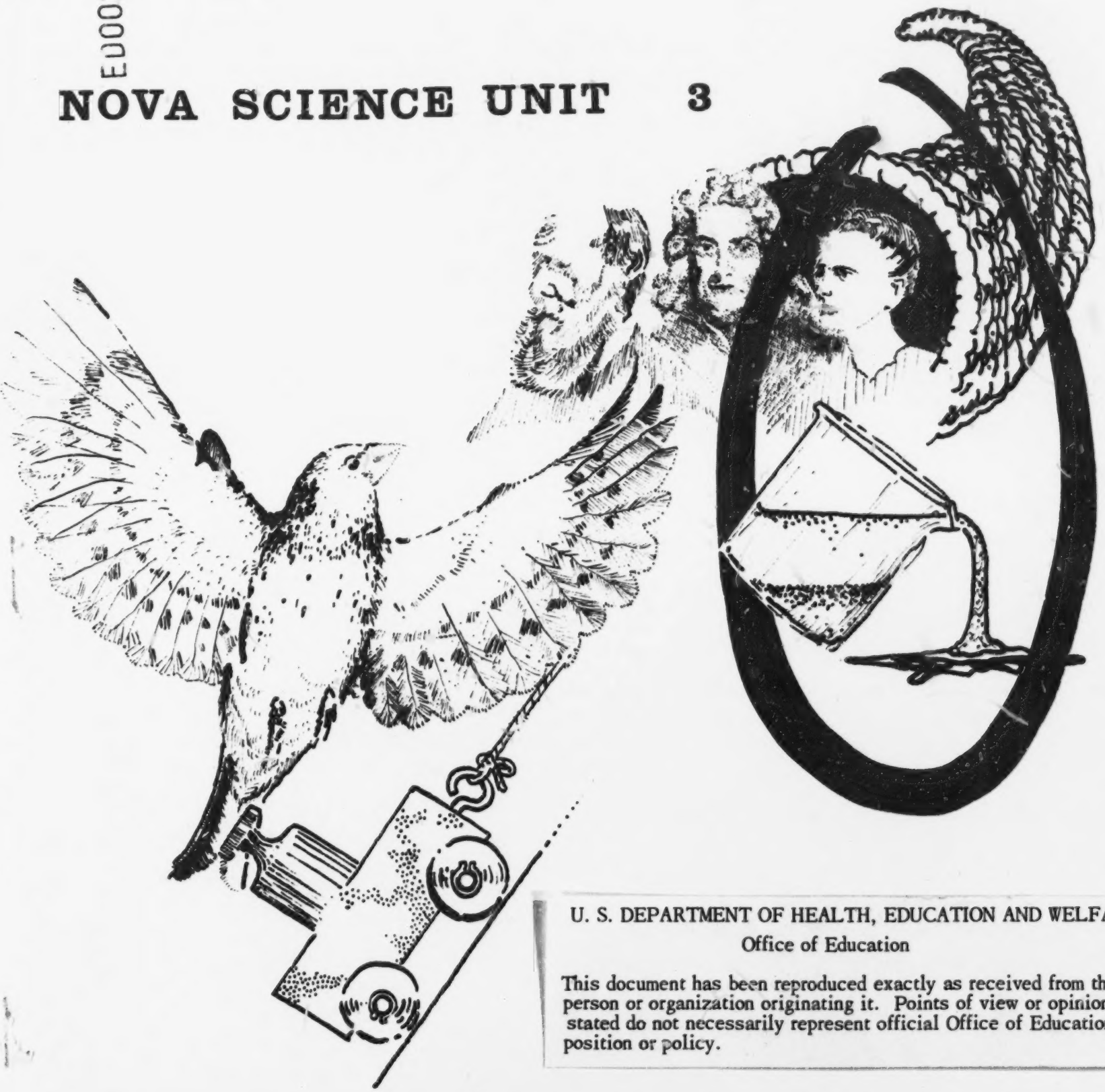

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ATOMIC THEORY

Variety. Nature has great variety. When we examined the stuff of unit 2 we found that there were many variable properties, some constant properties but much variety. Some of the chemistry you will encounter is the very slow process of rusting, the explosive action of hydrogen gas when it burns. Variety everywhere we look. We could tabulate all of these varieties as you have done in past experiments. But merely cataloging of observations is not science. We must use our observations, catalogue them and look for regularities. When we do this we are starting to work like scientists. Since chemists have been able to make more than a million compounds this would be an extremely long job if you started to do it. Fortunately, this has been done and the results have been placed in a chart called a Periodic Table of the Elements. This system of cataloging will be the basis of our study for several weeks.

For Further Study:

1. The Life of Dimitri Mendeleev
2. The Periodic Table of the Elements.

The periodic table lists chemical elements in a systematic method. It is a very valuable tool in understanding chemistry. Before we can really use this tool we need some understanding of what atoms are. From your studies you know that stuff occupies a certain volume. We can also assume that atoms have volume. Practically all of the stuff of an atom is found in a small compact region call the nucleus. The rest of the volume of the atom is occupied by electrons. As you remember all matter is of an electrical nature. Our studies showed that some particles of stuff have negative electric charges and others have positive charges. Also when positive and negative charges are brought together the net result is no apparent charge. So with the atom. The

nucleus has many particles in it that carry a positive charge. The electrons have a negative charge. When a number of electrons equal to the positive particles in the nucleus surround the nucleus then we have an atom with no apparent charge. Try this for yourself. Test such materials as sulfur, copper and others and see if you can detect an electrical charge. So we see that atoms are made up of a nucleus with a positive charge surrounded by electrons with a negative charge. When there are an equal number of positive and negative charges we have a neutral atom.

For Further Atom

1. What is the result of removing or adding electrons to a neutral atom?
2. What are ions?
3. What are protons?

Given a choice, one activity may be more popular than another. The electrons may be attracted to one substance more than another. You may have rubbed the rod real hard, expecting that some sort of work is knocking them loose, but it isn't . All that is required is that you provide an electron with a space on the place of its preference. You can read a book about this and it will tell you that a rubber rod rubbed with fur will take on electrons. We say that the rubber rod has become negatively charged. We already said that electrons will go from where they are to where they aren't (if it is still in the material of their preference.) What would happen if another rubber rod, just like the first, were brought in contact with the first? If the rubber rod, rubbed with fur, will attract paper, what about the fur? Suppose that we rub a balloon with cat's fur. What is the balloon made of? What do you suppose will happen if you rub the balloon with fur? Try it. Rub two balloons with fur. How do they react to each other? How do they react to the fur? To a charged rubber rod? What attracts a negatively charged balloon? What repels it? State what happens generally in as brief a statement as you can and have it accurate. Try other things: Charge the balloon with cat's fur. What is its charge? Rub a piece of glass with silk. What is its charge? Now can you show this?

Use several non-conductors and try to establish the charge on them.

By means of two balloons, experiment and see how the force between two charged objects changes as you charge the distance between them.

Electrons can be boiled off certain materials and made available for study. When we study these we find, sure enough, they are repelled by a rubber rod that has been rubbed with fur. We are able to isolate another particle that is much heavier than the electron but behaves in an opposit fashion. It is attracted to the charged rubber rod. We called it the proton.

Protons are in the nucleus and electrons surround the nucleus. This nicely takes care of the volume of an atom. But wait a minute; if we consider volume then certainly we have a problem with mass. Well, scientists have been able to determine the mass of small particles. These are their results:

Particles	Charge	Mass (Relative to the Proton)
Electron	1 -	$\frac{1}{180}$
Proton	1 +	1
Neutron	0	1

What do these mean? We find electrons around the nucleus and from the above we see that electrons weigh next to nothing so very little mass of the atom is to be found in the volume occupied by the electrons. What do that leave? The nucleus with its heavy protons. We come to the conclusion that most of the mass of an atom is in the nucleus. The neutron? We'll meet this particle again but in the meantime do some research on this particle. Now what do we have? A heavy nucleus surrounded by extremely light electrons. A nucleus with a positive charge and electrons with a negative charge.

For Further Study

1. What are neutrons?
2. What is the weight of a neutron?
3. What other particles have been found and identified in the atom?

How large is an atom? We can't see atoms but scientists have devised methods of measurements (remember your first unit on measurements) that tell us much about the size of atoms. Suppose we take Yankee Stadium with its seating capacity of 67,000 people as a model for the atom. To keep the right scale the nucleus would be about the size of a flea. A little flea! For the hydrogen atom the flea would represent one proton. He would be located at the center of the stadium somewhere around second base. The one electron would wander around occupying <u>all</u> the rest of the stadium. For the helium atom the nucleus would be replaced by four fleas representing two protons and two neutrons. The two electrons of a neutral atom would now share the ample space of the stadium. To make the picture more complicated you must remember that the fleas in center field represent almost all the mass of the atom. Scientists have been able to use mathematical terms instead of fleas even though the fleas would probably be more interesting. The diameter of an atom varies from 0.000 000 01 cm to 0.000.000 05 cm ($1X10^{-8}$cm). Nuculei are much smaller. A typical mucleus diameter is 10^{-3}cm, or about 1/100,000 the atom diameter. Now do you wonder why we cannot yet see atoms???

For Further Study

1. Build a picture of the atom as we have studied it to date.

As we study atoms we see that each chemical element consists of atoms whose nuculei contains a particular number of protons and thus a particular electric charge. For purposes of tabulating our observations we call the number of protons in the nuculeus the atomic number. Study the periodic chart that has been furnished you. Generally the atomic number is in the upper right hand of the box for each element. As you study your chart investigate the following:

1. If the atomic number tells us the number of protons in the nuculeus it also tells us something about the neutral atom. Can you discover this for yourself?
2. Can you observe any regularity about the atomic numbers?
3. How many different chemical atoms are represented on the chart?

All of the atoms of one element have the same nuculei charge. Since charge of electricity is the same this is no special problem. But what do we mean by mass. The other number in the box of each element is the mass number of an element. Does this mean the mass of one number? Let's look at element number 6. If the mass number of carbon is 12.01 as shown on your chart and one atom of carbon has a mass of 12.01 grams then we certainly should be able to see a carbon atom. But we can't see atoms so we can safely assume that mass number and the weight of one atom are not the same. What does the mass number represent? Chemists use this number to tell how much one atom is heavier than another. As a reference the hydrogen atom is used and the mass number tells us how much heavier an atom is in relation to the hydrogen atom. The mass number also tells us how many particles are in the nucleus of an atom.

Atomic Number - Number of protons in the nucleus number of electrons around the nucleus.

Mass Number - Number of protons and neutrons in the nucleus.

References:

1. Film Strip "Atomic Structure"

2. Film Strip "Hydrogen, the Fundemental Atom".

3. Models

SIMILARITY OF REACTIONS

Reaction - the manner in which a substance will behave when subjected to a change in environment. One of the characteristics you had used to identify materials, that is stuff and things was the way it reacted to outside changes. We are going to cause some of these elements to react with other elements or compounds by a few simple observations be able to identify the results.

The first question we ask is just how can one cause a reaction to occur? Much of the time simply by bringing the two bits stuff or things together will result in one or both undergoing a change. Thus, if gaseous chlorine is brought into contact with water both substances appear. This disappearance of the gas in the ater is called dissolving and we can say the chlorine is soluble in water.

To persue this investigation further we must design some method of proving the water underwent a change. The disappearance of the chlorine is evidence, the chlorine is no longer chlorine but what about the water? We use things called indicators to show changes that take place in water.

Indicators - Tools of the scientist to help him discover the present of a change. The indicator does not tell you how much change has taken place only that there has been a change. We are going to use an indicator to see if the water in our experiment has changed.

Take water in a 250 ml beaker for the laboratory tap. Fill a test tube about 1/3 full of this water. Put 5 drops of phenolhylene to change as it did in your experiment. You might also wish to substitute methylene blue indicator as a substitute for phenolhylene in your experiment